PHILOSOPHICAL

TRANSACTIONS.

June 10, 1683.

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An Abſtract of a Letter from Mr. Anthony Leewenhoeck *of* Delft *to Mr.* R. H. *concerning the appearances of ſeveral Woods, and their Veſſels.*

The Preface to the Letter.

I am not ignorant that the preſent ſubject has been learnedly treated of, by the judicious *Malpighius* and Dr.

N. Grew; I have ventured notwithſtanding to repreſent the Veſſels in Wood after ſuch manner as they offer'd themſelves to me. B. C. D. Fig. 1. is a part of the circumference of an Oak or Aſh Tree &c. being of 18 years growth and therefore having 18 Rings for every year one, that which is made the laſt year being alwayes the greateſt, tho not alwaies proportionably great, but according as the year is more or leſs fruitful.

[a] The pieces deſcribed in my following Figures are ſuch as [*] E in the 15th Ring, and ſometimes not ſo big: yet from ſuch a part I doubt not but the Conſtitution of the whole Tree may ſufficiently be underſtood.

When a Tree is ſawed a-croſs, and afterwards plaind very ſmooth, we [b] ſee lines as it were drawn from the Center A. and reaching to the Circumference B. theſe are Veſſels which carry the Sap to the Bark; as by the adjoyned Figures will appear.

The LETTER.

MY laſt to you was of the 20th of *November*, wherein I acquinted you of my thoughts of the Stone, Gravel, and Gout; which I hope you have received. You recommend to me in yours of the 17th of *October*, to examin fruitful and unfruitful Eggs. I have examined the Spots of ſeveral Eggs, but have found nothing notable therein. I will endeavour to know whether the Egg be fruitful before I examin it.

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[a] *The ſame noted by* Dr. Grew *Anatomy of* Trunks p. 24.

[*] *Note the Figures as they are here graved are not ſo big as thoſe deſigned by the Authour being ſometimes but* $\frac{1}{5}$ *(or other part) of their length, and ſo muſt be ſuppoſed not to reach from Ring to Ring as* E.

[b] *The ſame which Dr.* Grew *calls the* Inſertions, *Anatomy of Plants begun,* Chap. 2. *And Diametral Rays, Anatomy of Tr. p.* 20, 50, *&c.*

The Graſshoppers hereabout are ſmall and few, about the length of the Nail of ones hand: poſſibly in your Country they are more and greater.

We are very ſhy here of cutting open bodies, even of thoſe that are dead in the Hoſpital: ſo that I have no opportunity of knowing whether the Chalky matter be in the Veins or no.

I ſend you herewith ſome Obſervations of Wood. Fig. 2. A B C D ſhews a piece of Oak, which obſerved in a Microſcope was thus drawn from a piece of Wood as big as H.

F F: F F where the brown ſtroaks appear, are the Separations of the growth of one year. For when the growth doth ſtop, the Wood becomes firm, and thick; and is ſupplied with many ſmall Veſſels, ſuch as are hardly to be diſtinguiſhed, and therefore appear as brown Rays or ſtreaks. between the ſaid F F. F F is comprehended that thickneſs of Wood which has been added to the Circumference of a Tree by a years growth. The Wood hath five[c] ſorts of Veſſels, *viz.* Three ſorts going upwards, two lying Horizontally. E E E denote large aſcending Veſſels made every year in the Wood in the Spring, when it begins to grow. Theſe are filled within with ſmall Bladders, which have very thin Skins, here expreſſed in one of the greater Veſſels, cut long ways in the third Figure by I K L M.]

The ſecond ſort of riſing Veſſels are much ſmaller, which alſo are made of very thin Skins, and are alſo ſpeck't with parts which by a common Microſcope appear like Globules, as Fig. 4. O N where one of the ſaid Veſſels is cut longways.

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[c] *See a Figure of the ſame wood with all the ſame five parts, in Dr.* Grew's *Anat. of Plants begun. And the Partitions of the Great Horizontal Parts, hereafter mentioned, ſee in his Anat. of Roots, Tab. 7.*

The third ſort of riſing Veſſels are very ſmall and in great number, being made alſo of very thin Skins, as Fig. 4. P Q where they are drawn longways.

All theſe aſcending Veſſels in the aforeſaid piece of Wood, which is about $\frac{1}{90}$ of a Square Inch, are I gueſs about 20000 Veſſels. Hence in an Oak Tree of four foot Diameter are 3200 Millions of aſcending Veſſels, and in one of 1 foot, there are 200 Millions of Veſſels. If we ſuppoſe 10 of theſe great and ſmall Veſſels in a day to carry up 1 drop of Water, and that 100 of theſe drops make one Cubick Inch, there will be 200000 Cubick Inches. Theſe Inches reduced to feet, amount to full 115 Cubick feet of *Rhinland* meaſure, of 12 Inches to the foot; and one Cubick foot weighing 65 lib. of our *Delph* water, the whole will amount to 7475 lib. or 14 Bordeaux Hogſheads of water, which a Tree of one foot Diameter in one day can bring up. Whereby it appears, that how ſmall ſoever the Quantity of water is which a Pipe or Veſſel may be ſuppoſed to carry up, yet if all the Veſſels were imployed to that uſe, how much the Total would amount to. But I conceive that ſeveral of theſe Veſſels convey of the ſame moiſture downwards again to the Root, and ſo cauſe a Circulation: as I have formerly ſaid.

Theſe forementioned upriſing Veſſels empty conſtantly their Sap into an incredible number of Veſſels, which lye Horizontally in the body of the Tree, to cauſe a continual growth in thickneſs. Fig. 2. G G G are a ſort of Veſſels which run Horizontal, beginning from the Pith of the Tree, but afterwards in great numbers taking their riſe from the aſcending Veſſels. Theſe Veſſels appeared to me like dark ſtreaks running crooked, and winding for the moſt part along the ſides of the great Veſſels. To obſerve theſe Veſſels better, I cauſed the Wood to be cut in length in ſuch manner that I came to divide the ſaid Veſſels a-croſs very neatly. The ſame Veſsels lye not above 5, 6, or 7 one above another, as they are here drawn between the upriſing Veſsels P Q O N. Fig. 4.

The ſecond ſort of Horizontal Veſsels which lye in great numbers together, but in ſome places much more then others, are deſcribed Fig. 2. A *B* or C D: but when we cut the Wood in pieces longways, and thereby cut croſs theſe Veſsels, then they appear to our naked Eye as Fig. 5. R S. I have alſo drawn the ſame in many places at their length, with crooked Partitions, [d] which I judged to be Valves tho I have not been able to ſee them always ſo clearly as they are here expreſsed, but after I had found them ſome times, I concluded them to be generally ſo, both becauſe I have ſeen them in Elm Wood, as alſo that I concluded without theſe Valves it were impoſſible the Tree ſhould increaſe in thickneſs, becauſe of the force that is neceſsary not only to [e] ſeparate the Bark in the Spring from the wood, and keep it looſe; but alſo to cleave and open the Bark all the time the Tree is growing; and thereby make place for its increaſe in thickneſs. Now if there were none of theſe Valves, then the Sap which was impelled by the heat of the Sun againſt the *B*ark, with the ſetting of the Sun (when I conceive the Sap ceaſes [f] to riſe) would fall back again, and cauſe a labour in vain. In this ſmall piece of Wood Fig. 4. T, V. (deſcribed by a magnifying Glaſs which augmenteth more then that by which the Upriſing Veſſels are drawn, that ſo the Veſsels might appear more diſtinct) there are more then 2000 Veſsels, each of which if it be allowed but $\frac{1}{6}$ of a Grain of force in the protruding

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[d] *Sig.* Malpighi. *and Dr.* Grew *do both make theſe Partitions to be the Terminations of the bladders of which theſe Radiated parts conſiſt, and not Valv's. See the forementiond Anatomy of Tr, Fig.* 21. *p.* 21, 22. *and Anat. of Roots, Tab.* 7.

[e] *Dr.* Grew *thinks that the Bark is never ſeparated from the Wood. See Anat. of Tr. p.* 52. *&c.*

[f] *Yet Vines and other Plants do bleed day and night.*

its

its moiſture, the force, all theſe Horizontal Veſsels together muſt uſe towards the ſeparation of the Bark from the Wood, will appear by this Calculation. Suppoſe then that Fig. 4. is $\frac{1}{700}$ of a Square Inch, and that in the whole piece are but 2000 Veſsels, which make in a Square Inch 1400000 Veſsels, that is 350000 Grains; this number divided by 10240, which is as many Grains as make a Pound, makes full 34 Pound, for the force which the Veſsels in ſo ſmall a piece of Wood come to exerciſe upon the *B*ark. When we examin the Bark thus torn from the Tree, we ſhall ſee the Upriſing Veſsels of which the Bark is for the moſt part conſtituted, and which from the firſt formation went up ſtreight, and were placed regularly one by another, now in ſome places lye wide from one another, and in ſome cloſer, but this is not the Natural Conſtitution.

We know that there is great difference between Oak wood growing in high, and low ground; or in cold, or warmer Countries; or of ſlow or quick growth: but this piece here drawn was a cloſe good wood, and therewith of a full growth. When we cut any wood through, in its length, ſo that the cutting of the Knife cleaves the Horizontal *V*eſſels aſunder, it will ſeldom happen that the cutting of the Knife will handſomely cleave the veſsels. But the Knife for the moſt part cuts the Riſing and Horizontal veſsels aſlant; which cauſeth a falſe appearance, as if the Riſing and Horizontal veſsels were knit one into [g] another, as Linnen or Baſket-work: and to cut the Horizontal veſsels croſs, we muſt conceive the firſt time, that the Knife is gone through the Center of the Tree or Bough, and the ſecond time that the Knife is drawn parallel wth the firſt cut.

In Figure Sixth A B C D is repreſented a piece of Elm-wood (which to the naked Eye is as big as Figure E) and is what this Tree increaſed in one year in thickneſs.

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[g] *Dr.* Grew *and* Malpighi *do both repreſent them interwoven.*

A

A D and B C ſhow the ceaſing of the growth in the years end.

The ſmall Riſing veſsels which lye together between the great veſsels, are in this wood ſmaller then in Oak, and therewithal each Pipe conſiſts of a thicker Film, then the Pipes of the Oak do.

A B and C D ſhew the Horizontal veſsels at full length.

Fig. 7 F F F F ſhew the Horizontal Veſſels cut a-croſs; thoſe of them which lye but few together, I conceive to be Veſſels lately proceeding out of the riſeing Veſſels: whereas on the contrary the other Veſſels which lye many together, have ſubſiſted many years, and are as many in number as they ever will be. G G G G. ſhew the ſmall riſeing Veſſels at length.

H H Shews one of the great riſeing Veſſels in length, cut croſs in the midſt; yet when we obſerve the ſame more exactly we ſee that they conſiſt of very thin Films, beſet with Helical Threds, exhibiting obſcure ſpots upon the hoops or bows as Fig. 3.

Among theſe Trees there are ſeveral which upon tapping yield a Sap. This Sap I have ſeveral times, and ſeveral years obſerved, and taken notice in it of divers ſmall Animals, which I could not imagine ſhould have come out of the Wood, but rather that they might have come from rain-water or Dew.

Figure 8. A B C D. is a piece of Beech (as big as Fig. F to the naked Eye) the thickneſs of one years growth, wherein one may plainly ſee at A D or B C the beginning and end of the years growth. In this Wood there are rerepreſented two ſorts of riſeing veſsels. *viz.* greater and ſmaller; and I imagine that there are alſo two ſorts of Horizontal Veſsels, which are very ſmall: one of which *viz.* E E E lyes but 1, 2, 3, or more together, as Fig. 9. which ſhows thoſe Veſſels cut through and marked by H HH.

the

The 2d ſort, which lye far aſunder, as in proportion D from G and are marked out in their length by D C: theſe veſſels are likewiſe very ſmall, and accordingly the riſeing Veſsels lye very cloſe one to another, they are likewiſe cut aſunder overthwart as Fig. 9, I, I.

K K K Are the great riſeing veſsels cut aſunder longwaies: which I generally obſerved to be beſet with ſmall parts, that through a Common Magnifying Glaſs ſeemed to be Globules.

Fig. 10. A B C D. Repreſents a little piece of Willow wood, as big to the naked Eye as Fig. F. the ſame conſiſts alſo of two ſorts of riſeing Veſsels, ſmall and great, the great ones beſet with little parts, ſeeming Globules. In the ſame I ſaw bending lines which heretofore I imagined to have been valves, as is repreſented Fig. 11, in one of the ſame riſeing veſsels marked by G. Theſe ſmall riſeing Veſſels have exceeding thin Films, which twas impoſſible for me to delineate with red Chalk, ſo finely as was requiſite.

In this Wood I ſaw but one ſort of Horizontal veſsels marked Fig 10 by E E E. Theſe veſsels are but few in compariſon of the Horizontal veſsels, which I hitherto have obſerved in other Woods. The ſame are not far extended in length, and for breadth they lie ſingle.

Fig. 11. H H H. the ſame veſsels cut a-thwart are repreſented between the riſeing veſsels being at their length.

In one of the great riſeing veſsels fig. 11. G G. I likewiſe ſhewed that they are beſet with little parts ſeeming Globules, but they are exceeding ſmall.

Fig. 12. Is a piece of Alder-wood the breadth whereof is about the bigneſs of the briſtle of a Hog, to the naked Eye. It conſiſts likewiſe of two ſorts of riſeing veſsels; whereof the ſmalleſt conſiſts of exceeding thin films, and the greateſt ſort of films beſet with little parts extreamly ſmall, to which you can give no other names then Globules.

Between A B. and C D. is the increaſe of the Tree in a years time.

E E E E. Are the veſsels which run Horizontal.

Fig. 13. F F Are the great riſeing veſsels cut through longwaies.

H H Are the ſmall riſeing veſsels.

G G The Horizontal veſsels cut a-croſs

Fig. 14. A B C D E F is a little piece of black *Mauritius* Ebeny Wood, exhibited by a Microſcope magnifying more then any of the former; becauſe theſe veſsels could not well be obſerved by the Ordinary Glaſses, and this little piece of wood wherein are ſhewn about 1100 riſeing veſsels, is no bigger than to be covered by an Ordinary grain of Sand.

I purpoſed at firſt to have drawn this Wood more at large, having intended to have ſhewn its decreaſe in the latter end of the year, and increaſe at the beginning of the year or Spring: *B*ut in my attempting I found that my labor would be fruſtrated, becauſe that wood grows in a Climate where it increaſes always: for the Iſland *Mauritius* lies in a few degrees North of the Tropick of *Capricorn.* In this wood I am perſwaded there are four ſorts of riſeing veſſels.

G G G Are great riſeing Veſsels, whereof ſome appear to have contained a fluid matter, which in drying ſeems to have cloſed them together in ſeveral places, as fig. 15, II where one of the Veſsels is plainly exhibited at length.

Fig. 16 Is likewiſe one of the greater veſsels (magnified more by a yet greater Glaſs) which was much more perſpicuous than the former; beſet alſo with exceeding ſmall parts

The 2d ſort of riſeing veſsels which are placed generally between the Horizontal veſsels A B C and H H are likewiſe in many places partly filled with black matter.

The 3d ſort of riſeing veſsels which follow the Circumference of the Tree are B and C D E

The 4th ſort of riſing veſsels are thoſe which go Checker-wiſe between the great riſing veſsels. Theſe veſsels are of a firm Wood, in proportion to the veſsels of other Wood; for the ſmall round which is placed in the white is only the openneſs of every riſing veſsel; and the white wherein the round is placed is the wood that formeth the veſsel; and theſe veſsels are ſo cloſe and firm joyned to one another, that they ſeem to be but one; as if we ſhould imagine that ſmall holes were bored regularly in firm wood.

Fig. 15. K K K. are the Horizontal veſsels cut croſs through: of which I have repreſented two in their length, fig. 14. A B C. and H H.

Fig 15. L L are ſmall riſing veſsels in their length cut one from another.

Fig. 17. Is a piece of Palm wood, drawn by the ſame Magnifying Glaſs that the *Mauritius* Ebony wood was. This Wood tho I examined a great deal of it, I could find little difference in the ſeveral parts; and therefore I have here contented my ſelf with deſcribing a ſmaller portion. It conſiſts (for ought I can find) of two ſorts of aſcending veſsels *viz.* Great veſsels, and ſmaller veſsels lying amongſt the great. The great Veſſels conſiſt alſo of Skins being beſet with ſmall riſeing particles, as in fig. 18. where the Veſſels are opened longwaies, and repreſented by E E E E.

The ſmall Veſſels have their cavities very like thoſe of the ſmall veſſels in *Mauritius* Ebony Wood; and are deſcribed cut the longwaies in fig. 18. F F.

A B or C D. are the Horizontal Veſsels which in their length ſhew themſelves thus; but being cut overthwart are as G G in fig. 18.

Fig. 19. A B C D E F. Is a deſcription of a very ſmall piece of Straw cut croſs, in which the part of the Circumference (A F) may be diſcerned how great it is.

A B E F Is the rind of the Straw, which to outward Appearance is ſmooth and ſhineing: tho for the moſt part 'tis made of extream ſmall veſsels, and of ſome greater, which I have repreſented as near as poſſible.

GGGG Are the *Veſſels* of which the innermoſt parts of the Straw are made; theſe veſsels are 4, 5, and 6. ſided according as they come to fit themſelves.

HHH Are veſsels which run in between the forementioned veſsels and are beſet round with ſmall veſsels. In theſe veſsels I have ſeen the ſap ſink down ſuddenly at the time of the growing of the Straw, when at the ſame time I ſaw the Sap riſe up in the veſſels G G. which Sap was made moſt of Globules; and when the Globules came to paſs the valves where the veſsels were narroweſt; theſe Globules then changed into the form of Cones, till they obtained a larger Room, and then they retook their former Globouſneſs

Fig. 20. are the riſeing veſſels deſcribed in their length, being the ſame with theſe repreſented fig. 19. G G.

IIII. Are the places where theſe Valves are, and where the veſſels are narroweſt.

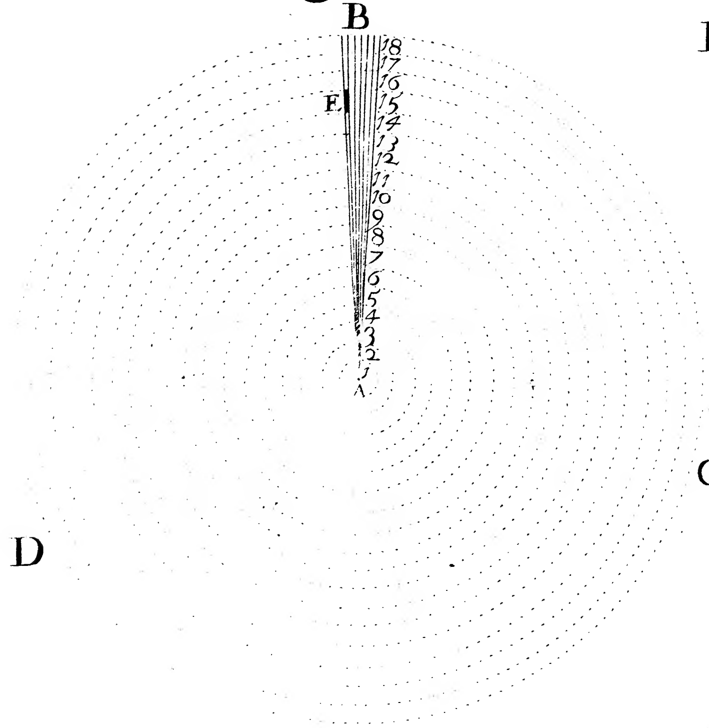
I have in mine of the 23 of *April* mentioned the great number of ſmall creatures in the Melt of a *Cod* or *Pike*. I have proſecuted my ſpeculation, and obſerved the Melt of a *Perch*; alſo of a *Breem* and a *Vooren*, as alſo of a *Tench*, at the time when they caſt their Seed: and have ſeen in the ſame an incredible number of ſmall Animals, as I mentioned in my former. But becauſe the forementioned fiſhes do not ſhoot their Seed at once; I have not been able to compare them together that I might if poſſible have diſcovered whether there were any difference in their ſhape or bigneſs: but ſo far as I could remember, I conceive there was no difference. And if any perſons are inclined to make the ſame obſervations, they muſt be ſure to take the time when the ſaid fiſhes ſhoot their Seed: for at that time the Melt, which is ready to come out, is thin and watery; and then theſe animals in it live longeſt, and move very briskly: whereas on the contrary the Melt being not full ripe, we muſt with force preſs it out of the Fiſh, and then tis difficult to ſee theſe Animalcules alive.

A Theory of the Variation *of the* Magnetical COMPASS, *by Mr.* Ed. Halley *Fellow of the R. S.*

THe Variation of the Compaſs (by which I mean the deflection of the Magnetical Needle from the true Meridian) is of that great concernmeut in the Art of Navigation: that the neglect thereof, does little leſs than render uſeleſs one of the nobleſt Inventions mankind ever yet attained to. And for this cauſe all Ships of Conſequence (eſpecially thoſe bound beyond the Equator) carry with them Inſtruments on purpoſe to obſerve this Variation: that ſo the courſe ſteared by the Compaſs, may be reduced to the true courſe in reſpect of the Meridian.

Now altho the great utility that a perfect knowledge of the Theory of the Magnetical direction would afford to mankind in general, and eſpecially to thoſe concerned in Sea affairs, ſeem a ſufficient incitement to all Philoſophical and Mathematical heads, to take under ſerious conſideration the ſeveral *Phænomena*, and to endeavour to reconcile them

Fig: 1.



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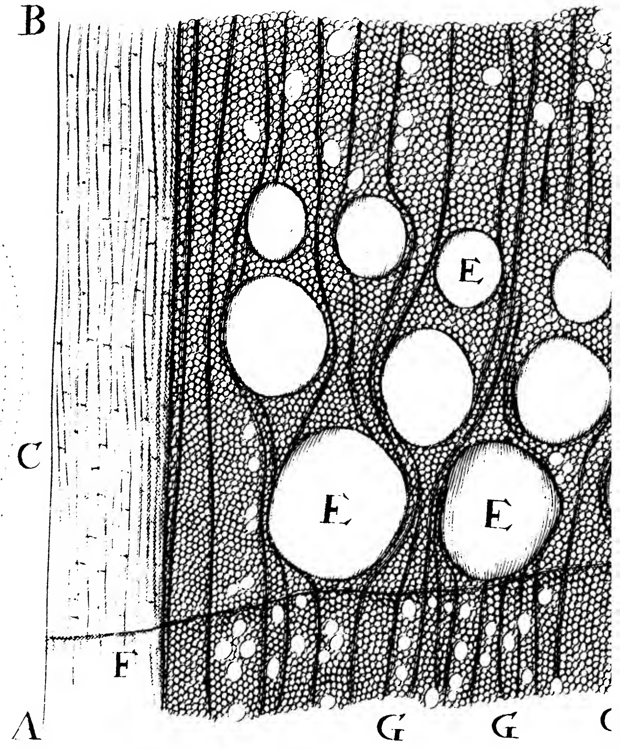


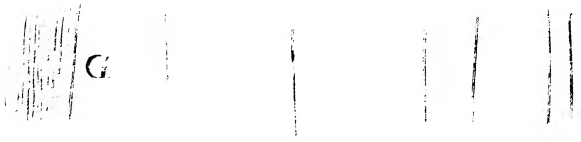
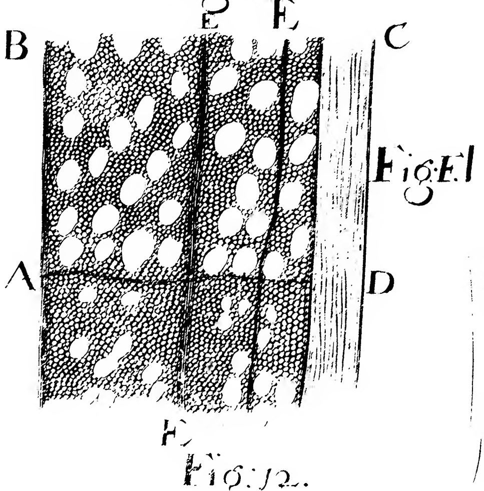


Fig. 8.



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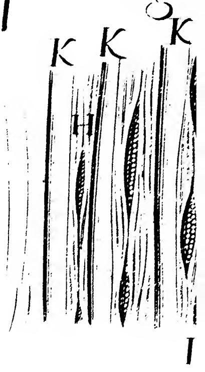

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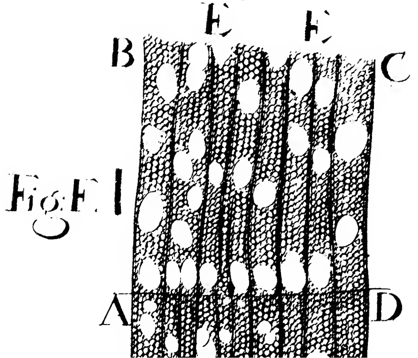

Fig: 11.

Fig: 12.

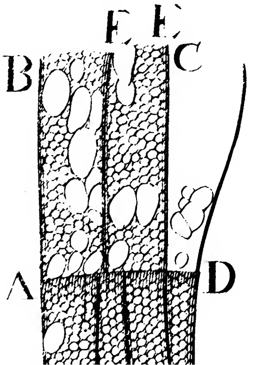

Fig: 13.

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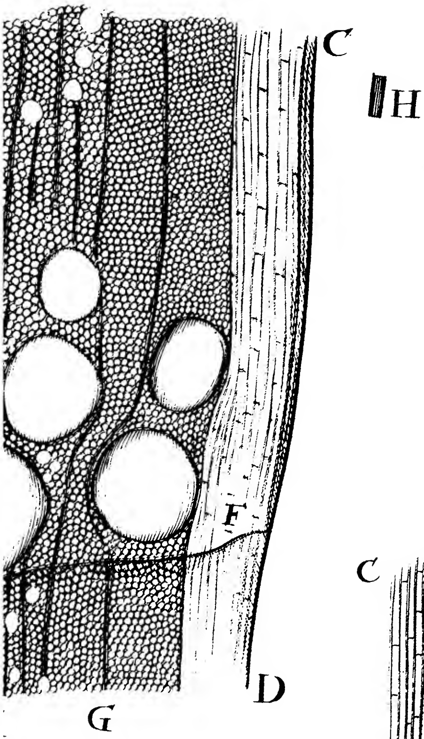
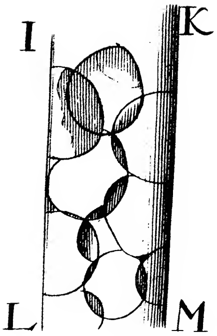


Fig: 3.



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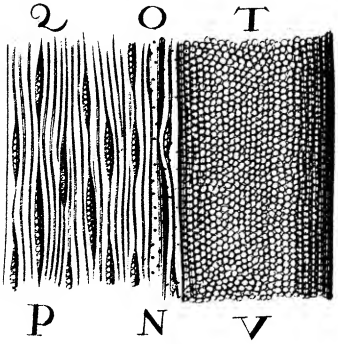

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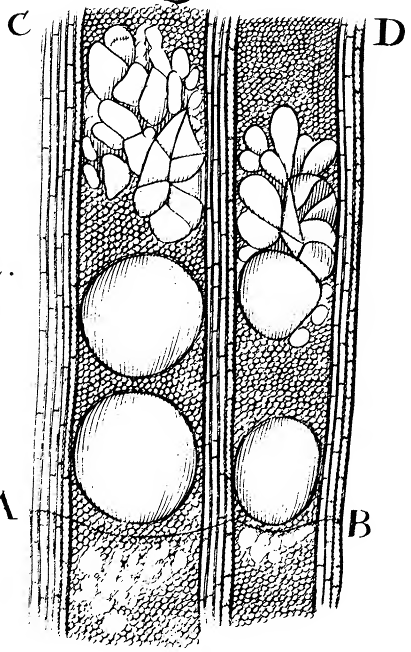

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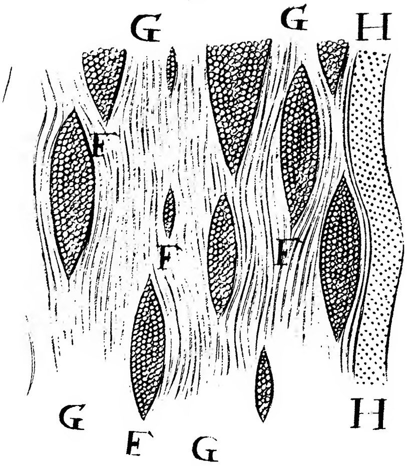
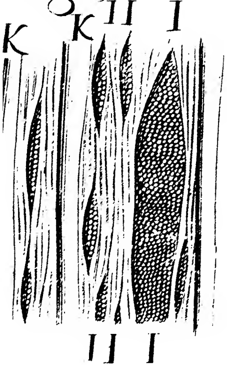


Fig: E.

Fig: 9.



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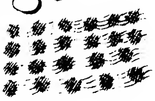

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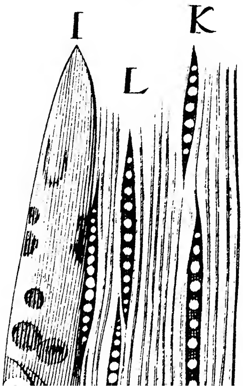

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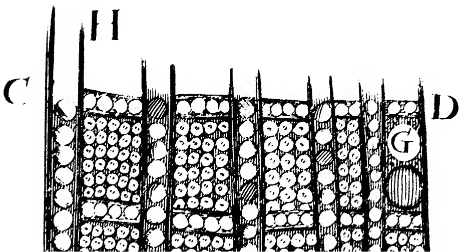

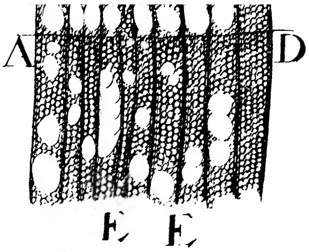

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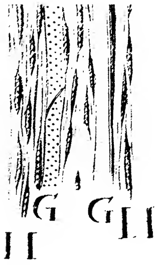

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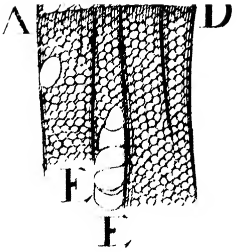

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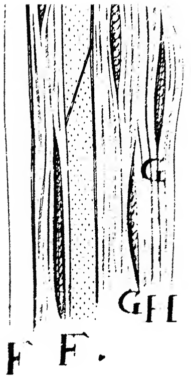

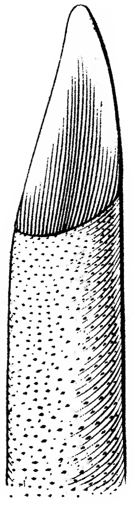

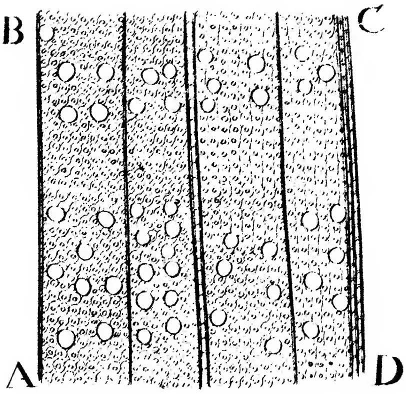

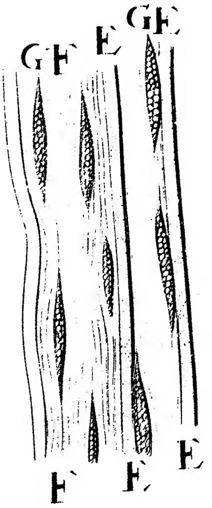

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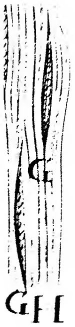

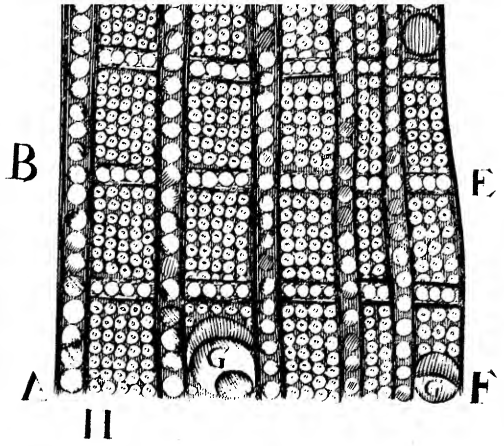

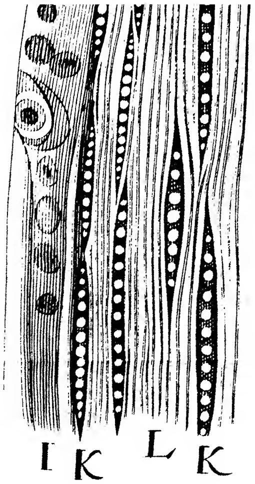

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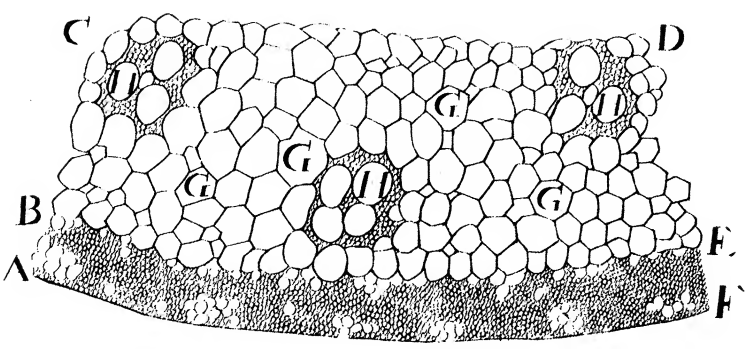
Fig:19.



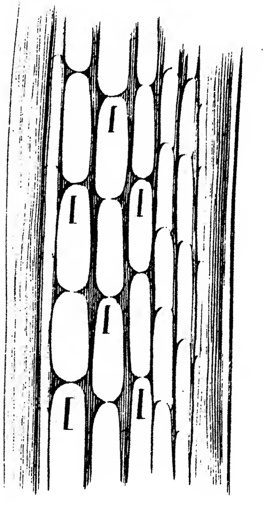


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Fig 1

Fig 2

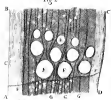


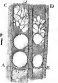
Fig 3

Fig 4

Fig 5

D

Fig 6



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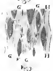

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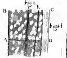

Fig 9

Fig 3

Fig 10

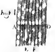

Fig 11

Fig 12

Fig 13

Fig 14

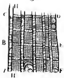

Fig 15

Fig 16

Fig 17

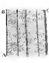

Fig 18

Fig 19

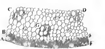

Fig 20

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